tures of Lord Kelvin, using a standard microfarad condenser, and employing the electrometer itself as indicator, is 0·363 microfarad at the part used in this experiment.

"On a Peculiarity of the Cerebral Commissures in certain Marsupialia, not hitherto recognised as a Distinctive Feature of the Diprotodontia." By G. ELLIOT SMITH, M.D., Ch.M., Professor of Anatomy, Egyptian Government School of Medicine, Cairo, and Fellow of St. John's College, Cambridge. Communicated by Professor G. B. HOWES, F.R.S. Received March 5,—Read March 20, 1902.

It has been known for a considerable time that some of the fibres of the ventral commissure of the cerebrum in certain Marsupials dissociate themselves from the rest of the commissure as soon as they have crossed the mesial plane; and that, instead of passing bodily into the *external* capsule, which is the usual course of the fibres of the ventral or anterior commissure, they form an aberrant bundle which associates itself with the *internal* capsule so as to reach the dorsal area of the neopallium by a shorter and slightly less circuitous course (fig. 2).

This peculiarity was represented in the drawings of sections through the brains of *Macropus* and *Phascolomys*, in 1865, by the late W. H. Flower.* It was more distinctly shown in a diagram† illustrating a coronal section through the brain of a Derbian Wallaby which was published 27 years later by Johnson Symington. Two years later I placed on record the observation upon it, that "in *Phalangista* [*Trichosurus vulpecula*] a bundle of anterior commissure fibres proceeds to the cortex *viâ* the internal capsule, in addition to the external capsule,"‡ and in the same place noted an analogous arrangement in various species of *Macropus*.

In 1897 Theodor Ziehen recorded§ the presence of such fibres in *Macropus*, *Aepyprymnus*, and *Phascolarctus*; but, like Flower and Symington before him, he did not venture on any explanation of them.

* "On the Commissures of the Cerebral Hemispheres of the Marsupialia and Monotremata, as compared with those of the Placental Mammals," 'Phil. Trans.,' vol. 155 (1865), p. 633.

† "The Cerebral Commissures in the Marsupialia and Monotremata," 'Journal of Anatomy and Physiology,' vol. 27, 1892, fig. 3, p. 81.

‡ "Preliminary Observations on the Cerebral Commissures," 'Proc. Linn. Soc. of N.S.W.,' 1894, pp. 647—648.

§ "Das Centralnervensystem d. Monotremen und Marsupialia (Semon's Zoologische Forschungs-Reisen in Australien)," 'Denkschr. Medic.-naturwis. Gesellsch. Jena,' vol. 6, Lf. II and IV, 1897—1901.

The investigations for my memoir of 1894 were carried out chiefly on the brains of *Ornithorhynchus*, *Perameles*, *Trichosurus*, and *Macropus*.

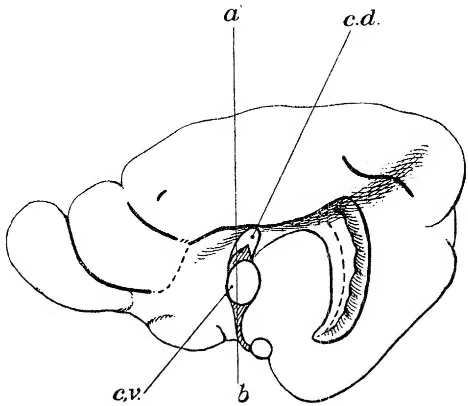


FIG. 1.—*Trichosurus vulpecula.* The mesial aspect of the right cerebral hemisphere. × 2.

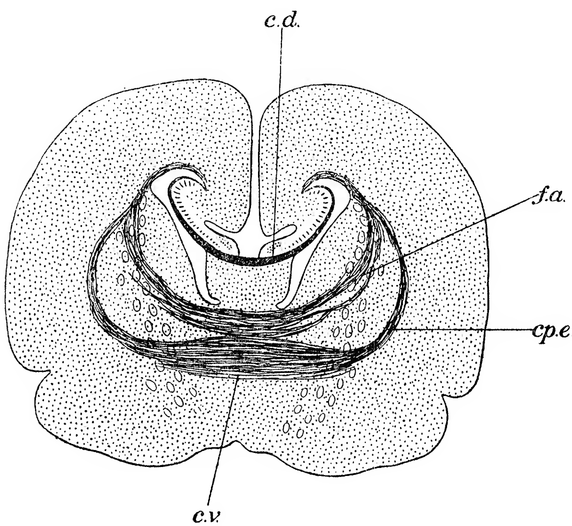


FIG. 2.—Transverse section through the two cerebral hemispheres of the same in the plane *a*, *b* (fig. 1). × 3.

c.d., commissura dorsalis. *c.v.*, commissura ventralis. *cp.e.*, capsula externa. *f.a.*, fasciculus aberrans.

In the Monotreme and the smaller Marsupial (*Perameles*) the common Mammalian relationship of the ventral commissure to the external

capsule was found to obtain, but in the two larger Marsupials some fibres of the ventral commissure were found to pursue the aberrant course indicated above. It was perhaps not unnatural to suppose (as I did in that early attempt at interpreting this peculiarity) that the increased size of the neopallium in *Trichosurus* and *Macropus* was wholly responsible for the presence of this aberrant bundle. For it seemed that since the commissural fibres of the neopallium had become too abundant to be wholly accommodated by the path provided by the external capsule, they, so to speak, had overflowed into the internal capsular route.

Upon examining a much larger series of Marsupials than were available when my memoir of 1894 was written, I soon became convinced that the explanation of the causation of this peculiarity which I then suggested could not be regarded as alone sufficient. I found the aberrant bundle in all members of the genera *Macropus*, *Halmaturus*, *Hypsiprymnus*, *Dendrolagus*, *Trichosurus*, *Petaurus*, *Phascolarctus*, and *Phascolomys*, quite irrespective of the size of the brain and of the extent of the neopallium. On the other hand, I sought in vain for it in *Perameles*, *Sarcophilus*, *Dasyurus*, *Sminthopsis*, *Didelphys*, *Myrmecobius*, and *Notoryctes*, even though many of these genera possess larger brains than some of the Diprotodonts.

These facts seemed to suggest that the aberrant bundle was essentially a distinctive feature of the Diprotodont Marsupials, and it appeared to me that the crucial test of this hypothesis would be afforded by the examination of the brain of *Thylacinus*, which, although that of a Polyprotodont, is almost, if not quite, as large as the brain of the largest Macropod, and considerably larger than those of all other living Diprotodonts. I accordingly submitted the cerebrum of *Thylacinus* to the test, and found no trace of the aberrant bundle (figs. 3 and 4), *wherefore it is clear that the presence of this aberrant fasciculus of the ventral commissure is distinctive of the Diprotodontia.*

If we compare the brain of the Diprotodontia with that of the other three Mammalian groups: Monotremata, Polyprotodontia, and Eutheria, the meaning of the aberrant bundle becomes, I believe, fairly obvious.

A study of the structure of the brain in the Monotremes and the Polyprotodont Marsupials shows that in the progenitor of the Mammalia all the commissural fibres of the neopallium must have passed into the ventral commissure *viâ* the external capsule (fig. 4).

The most pronounced growth tendency in the earliest Mammals must have been the enormous increase of the extent of the neopallium, for while at the beginning of the Eocene period this was almost as insignificant as it is in the Reptilia, in most recent Mammals it attains a bulk which far exceeds that of the whole of the rest of the nervous system. This sudden expanse of the neopallium would lead to the

development of an enormous mass of fibres which must find some outlet from the pallium. There are only three possible routes for

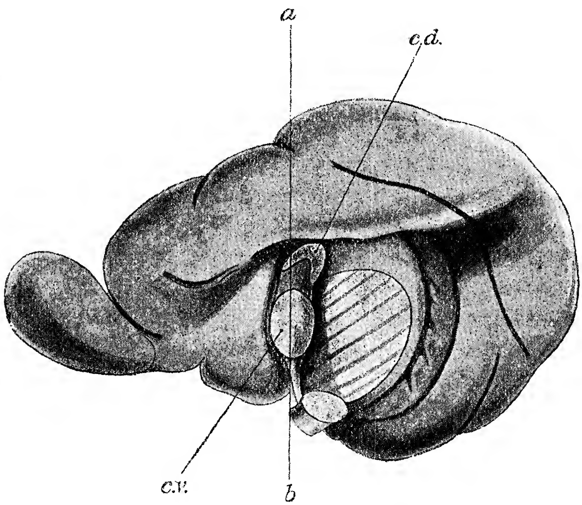


FIG. 3.—*Thylacinus cynocephalus.* The mesial aspect of the right cerebral hemisphere. Nat. size.

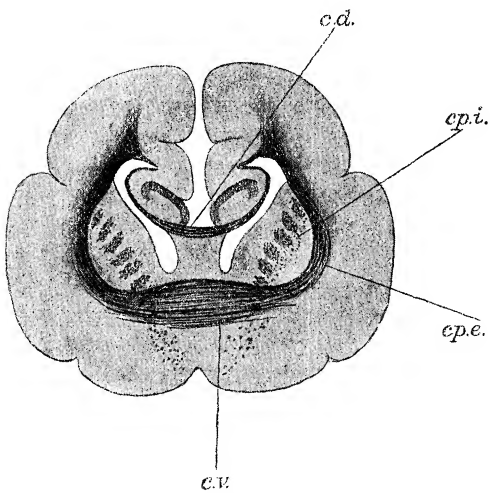


FIG. 4.—Transverse section of the two cerebral hemispheres of the same in the plane *a*, *b*. (fig. 3).

cp.i., capsula interna. Other references as for fig. 2.

commissural fibres of the neopallium to the mesial plane. There is first of all the external capsule, which chiefly consists in all Mammals of such fibres passing to the ventral commissure: we find the second route in the path mapped out by the internal capsule from the dorso-lateral neopallial area to it; and the third route can only involve the invasion of the alveus of the hippocampus.

These three routes, by which a fibre coming from the dorsal neopallium in the region x (fig. 5) may attain the region y in the other hemisphere, are indicated schematically in the following diagram:—

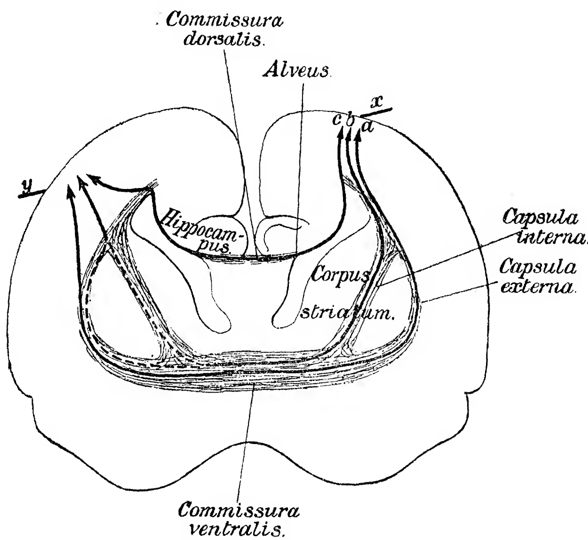


FIG. 5.—A scheme of a transverse section in the same plane as that represented in figs. 2 and 4 to show the three routes a, b, and c by which a commissural fibre may pass from the point x in one hemisphere to the region y in the other in different mammalian brains.

ALL the neopallial commissural fibres in the Polyprotodontia and SOME ONLY of these in the Diprotodontia and Eutheria follow the first, which is also the primitive, route (a). The commissural fibres, which spring from the dorso-lateral region of the neopallium in the Diprotodontia seem to be crowded out, as it were, of the first route and pursue the second route (b). In the Eutheria the neopallial commissural fibres from the dorso-lateral region of the hemisphere forsake both the first and second routes and break through the hippocampal formation (c), or, in other words, invade the alveus so as to form a new dorsally situated neopallial commissure which is the corpus callosum.

This hypothesis of the origin of the corpus callosum I have pre-

viously stated in my memoir of 1894 (*vide supra*) and I discussed it more fully in 1897.*

I refer to the matter now, merely to point out that the same determining cause which in the Eutheria calls the "corpus callosum" into being is probably functional in bringing into existence the "aberrant bundle" in the Diprotodontia.

When the relations of these commissural bundles in the four divergent mammalian groups—Monotremata, Polyprotodontia, Diprotodontia, and Eutheria—are carefully studied we are able to appreciate one—and by no means the least—of the reasons why the Eutheria have attained such a pronounced ascendency over the other three groups.

Their brain is that which has retained that particular modification of the commissural arrangement which not only furnishes the shortest and most direct path of communication (*c*) between the two hemispheres, but also permits of an unimpeded expansion (which is so freely exercised by the corpus callosum). In the other three groups, in which all the neopallial commissural fibres pass through the ventral commissure, the undue expansion of the latter would produce considerable disturbance in the surrounding structures, which in turn would exercise a restraining influence upon any marked increase in size in the commissure itself.

The development of any such commissural mass as the corpus callosum of the more highly organised Mammalia in the position occupied by its homologous fibres (fig. 3, *a* and *b*) in the Monotremes and Marsupials would cause the most profound disruptions of the corpus striatum, optic thalamus, and the basal region of the brain, and the complete disorganisation of its whole.

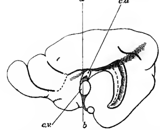
For these various reasons the development of the corpus callosum gives the Eutherian brain a great advantage in the struggle for supremacy, which must have exercised a considerable if not predominant influence in making the Eutheria the highest Mammals.

"A New Interpretation of the Gastric Organs of Spirula, Nautilus, and the Gastropods. By J. E. S. Moore and W. B. Randles, B.Sc. Communicated by Professor G. B. Howes, F.R.S. Received March 17,—Read April 24, 1902.

(From the Zoological Laboratory, Royal College of Science, London.)

Related to the stomachs of some Gastropods and Lamellibranchs there are two conspicuous appendages, the so-called crystalline style-sac and the so-called spiral cæcum.

* "The Origin of the Corpus Callosum," 'Trans. Linn. Soc. of London,' 2nd series, Zoology, vol. 7, part 3, June, 1897, p. 61.



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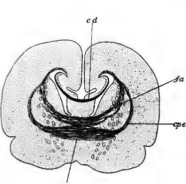

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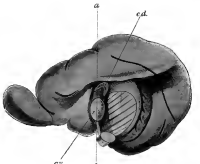
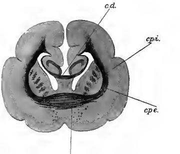


Fig. 3.—*Thylacinus cynocephalus.* The mesial aspect of the right cerebral hemisphere. Nat. size.



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